Appendix L

GHG Calculations

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Plummer Solar Project
GHG Calculations

Table 1. Summary of Operations GHG Emissions

Emission Source	CO_2 (metric tons/year)	CH_4 (metric tons/year)	N_2O (metric tons/year)	CO_2e[1] (metric tons/year)
Direct Sources				
Mobile Combustion	7.93	3.43E-04	6.98E-05	7.96
Land Use Change	--	--	--	1,409.36
Indirect Sources				
Electrical Consumption	20.33	2.18E-03	3.06E-04	20.47
TOTAL - ALL SOURCES	28.26	2.53E-03	3.76E-04	1,437.80

[1] CO_2e calculated by equation A-1 of 40 CFR 98.2, which states the total CO_2e is equal to the GWP for each pollutant multiplied by the potential pollutant emissions. The GWP for CO_2 is 1, CH_4 is 25, and N_2O is 298.

Table 2. Conversions

Unit	Amount	Unit
1 US ton	2000	lbs
1 US ton	0.907185	metric tons
1 US ton	907.185	kg
1 US ton	907185	grams
1 lb	453.592	grams
1 MWh	1000	kWh
1 hectare	2.47105	acres
1 US gallon of diesel	144.945	MJ
1 MJ	0.372506136	hp-h
1 US gallon of diesel	53.9929019	hp-h
Heating Value of Fuel	137030	Btu/gal
Break-specific fuel consumpt	7000	Btu/hp-hr

Table 3. Global Warming Potentials

Greenhouse Gas Name	CAS Number	Chemical Formula	Global Warming Potential (100-yr.)[1]
Carbon dioxide	124–38–9	CO_2	1
Methane	74–82–8	CH_4	25
Nitrous oxide	10024–97–2	N_2O	298

[1] Table A-1 to Subpart A of Part 98, Title 40, https://www.ecfr.gov/current/title-40/part-98/appendix-Table A-1 to Subpart A of Part 98

Table 4. Operations Emissions from Fuel Combustion Sources

Fuel Type[1]	Fuel Consumption[1], [2] (gallons/year)	CO2 Emission Factor[2] (kg/gallon)	CH4 Emission Factor[3] (g/gallon)	N2O Emission Factor[3] (g/gallon)	CO2 (metric tons/year)	CH4 (metric tons/year)	N2O (metric tons/year)	CO2e[4] (metric tons/year)
Gasoline	873	8.78	0.38	0.08	7.66494	0.000332	0.00006984	7.69404582
Diesel	30.65022258	8.78	0.38	0.08	0.269108954	1.16E-05	2.452E-06	0.270130833
TOTAL	--	--	--	--	7.934048954	0.000343	7.2292E-05	7.964176653

[1] Fuel consumption obtained from RFI from Enbridge. Fuel use was estimated as an average from similar Enbridge work sites.

[2] Fuel consumption for the diesel geneator was calculated based on a typical emergency generator engine output of 50 Hp, a diesel heating value of 137,030 Btu/gal, conversion of 7,000 Btu/hp-hr, and 12 hours per year of operation.

[3] Table 2, Mobile Combustion CO2. Emission Factors for Greenhouse Gas Inventories, EPA CCCL. April, 2023. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[4] Table 5, Mobile Combustion CH4 and N2O for Non-Road Vehicles. Emission Factors for Greenhouse Gas Inventories, EPA CCCL. April, 2023. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[5] CO2e calculated by equation A-1 of 40 CFR 98.2, which states the total CO2e is equal to the GWP for each pollutant multiplied by the potential pollutant emissions. The GWP for CO2 is 1, CH4 is 25, and N2O is 298.

Table 5. Operations Emissions from Electrical Consumption

Temporary Facility	Energy Consumption[1] (kWh/year)	eGRID Subregion	CO_2 Emission Factor[2] (lb/MWh)	CH_4 Emission Factor[2] (lb/MWh)	N_2O Emission Factor[2] (lb/MWh)	CO_2 (metric tons/year)	CH_4 (metric tons/year)	N_2O (metric tons/year)	CO_2e[3] (metric tons/year)
Operations	45000	MROW	995.8	0.107	0.015	20.33	0.00E+00	0.00E+00	20.33
TOTAL	--	--	--	--	--	**20.33**	**0.00E+00**	**0.00E+00**	**20.33**

[1] Electrical consumption obtinaed from RFI from Enbridge. Electrical consumption was estimated using an average from similar Enbridge work sites.

[2] Table 6, Electricity. Emission Factors for Greenhouse Gas Inventories, EPA CCCL. April, 2023. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[3] CO_2e calculated by equation A-1 of 40 CFR 98.2, which states the total CO_2e is equal to the GWP for each pollutant multiplied by the potential pollutant emissions. The GWP for CO2 is 1, CH4 is 25, and N2O is 298.

Table 6. Land Use Change Emissions

Permanent Land Use Change[1]	Area of Land Change[1] (acres)	2021 Net CO_2 Flux for Converted Land Type[2][3] (M metric tons CO_2e)	2021 Total US Land Use Change from Forest Land[4] (thousands of hectares)	CO_2e Emission Factor (metric tons CO_2e/acre)	CO_2e[5] (metric tons/year)
Forest Land to Settlement	0.03	63.7	456	56.53	1.74
Cropland to Settlement	709.89	5.9	1,366	1.75	1,240.82
Wetlands to Settlement	19.12	0.3	14	8.67	165.79
Grassland to Settlement	0.38	12.2	1,830	2.70	1.02
TOTAL	**729.41**	**82.10**	**3,666.00**	**69.65**	**1,409.36**

[1] Estimated from project area delineation files and NLCD land cover estimates.

[2] Table 6-129. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2021. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021

[3] Table 6-44. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2021. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021

[4] Table 6-5: Land Use and Land-Use Change for the U.S. Managed Land Base for All 50 States, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2021.

Table 7. Avoided GHG Emissions

Temporary Facility	Energy Consumption[1] (MWh/year)	eGRID State	CO2 Emission Factor[2] (lb/MWh)	CH4 Emission Factor[2] (lb/MWh)	N2O Emission Factor[2] (lb/MWh)	CO2 (metric tons/year)	CH4 (metric tons/year)	N2O (metric tons/year)	CO2e[3] (metric tons/year)
Operations	253500	Minnesota	825.973	0.082	0.012	94975.08	9.4288273	1.379828385	95621.99
TOTAL	--	--	--	--	--	94975.08	9.4288273	1.379828385	95621.99

[1] Electrical consumption obtinaed from RFI from Enbridge. Electrical consumption was estimated using an average from similar Enbridge work sites.

[2] U.S. eGrid Factors, 2023 Update, Total Output Emissions Rates for Minnesota, metric tonne/MWh; https://www.epa.gov/egrid/download-data

[3] CO2e calculated by equation A-1 of 40 CFR 98.2, which states the total CO2e is equal to the GWP for each pollutant multiplied by the potential pollutant emissions. The GWP for CO2 is 1, CH4 is 25, and N2O is 298.